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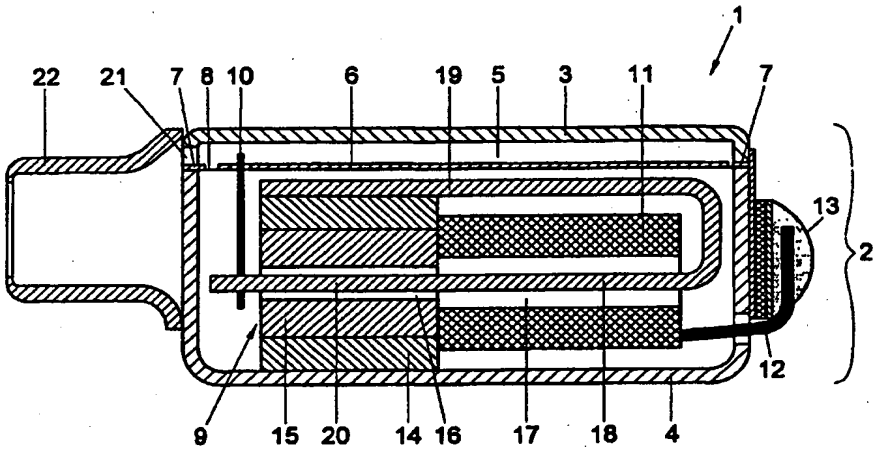


(57) Abstract

A method for manufacturing an electroacoustic transducer for, for instance, a hearing aid, with a diaphragm (5) arranged in a housing (2). According to the invention, the diaphragm is attached onto a film or punched from a sheet of material, such that along the circumferential edge of the diaphragm, a free strip of film or a strip of material (7) remains present. In a capillary space between the circumferential edge of the film and the inner wall of the housing, or in a capillary space (8) between the diaphragm and the strip of material, a polymer of a low viscosity is provided to connect the diaphragm with the housing wall. Through the method, the production of the transducer is greatly simplified.

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Title: Electroacoustic transducer with a diaphragm, and method for fixing a diaphragm in such transducer.

The invention relates to an electroacoustic transducer, comprising: a case; a diaphragm disposed in the case, comprising a central diaphragm portion and an edge portion extending therearound; means for, respectively, converting an electric signal to a vibration of the central diaphragm portion, or converting a vibration of the central diaphragm portion to an electric signal; while the edge portion of the diaphragm is connected to a wall portion of the case.

Such a transducer is known from NL-A-1004877 and finds application especially in hearing aids.

For the proper functioning of such a transducer, various requirements are imposed on the construction of inter alia the diaphragm. On the one hand, the diaphragm must be able to move freely, on the other hand it is, of course, necessary to secure the diaphragm somehow. It is therefore customary to attach the diaphragm by its circumferential edge to a support frame or to the case, whereby the central portion of the diaphragm remains unattached in order to be able to vibrate. Often, between this central diaphragm portion and the edge portion, a transition portion formed as a groove or bellows is included to give the central diaphragm portion as much freedom of vibration as possible.

From NL-A-1004877, it is also known to attach the diaphragm to a film, which film is attached to the case. To this end, the film is folded to enable free movement of the diaphragm. A complete suspension of the diaphragm is necessary to obtain a proper acoustic separation between the volume in the transducer above and under the diaphragm.

As already mentioned, an acoustic transducer is applied in, for instance, hearing aids, intended to be positioned in the exterior auditory canal of a person. Hence, there is, within this technical field, a continuous pursuit of

ever increasing miniaturization, demanding a great sensitivity of the various applied parts.

Apart from this pursuit of miniaturization, it is desired to enlarge the volume displacement by the diaphragm as much as possible, to which end it is desired that the central diaphragm portion be as large as possible. Additionally, it is desired to keep the costs of manufacturing the construction of the diaphragm as low as possible by applying as few parts as possible.

A drawback of all hitherto proposed manners of connecting a diaphragm to the case is the necessity of different production steps, each involving the possible occurrence of errors, which sometimes can and sometimes cannot be corrected, but always entail additional activities and hence additional costs.

The object of the invention is to provide a transducer of the present type and a method for the production thereof, in which these drawbacks do not occur. To this end, in a first exemplary embodiment, the invention is characterized in that the diaphragm is provided on a film, in such a manner that along at least a part of the circumferential edge of the diaphragm a free strip of film is present, and that between the circumferential edge of the film and the inner case wall a capillary space is present in which a polymer is provided as a connection between the circumferential edge and the inner case wall.

The invention also provides a method for fitting a diaphragm in a case of a transducer of the above-described type, characterized in that the diaphragm is attached to a film, in such a manner that along the circumferential edge of the diaphragm a free strip of film remains present and that in a capillary space between the circumferential edge of the film and the inner case wall a polymer of low viscosity is provided to connect the film edge to the case wall.

This embodiment of the invention has the advantage that the connection between the case and the diaphragm can be very elastic and therefore does not deform or tear even in the case of extensive deflections.

Also, the attachment is completely free of tension, which is very favorable to the acoustic properties of the diaphragm.

The polymer used should in any case have the property that it does not evaporate, does not influence the frequency response of the diaphragm, and is also able to resist particular strains. Polymers meeting these requirements are, for instance, polybutenes of different viscosities.

A second embodiment of the invention is characterized in that the diaphragm comprises a central portion and a circumferential edge located in the same plane, spaced apart from the outer edge of the central portion, the central portion and the circumferential edge being made from the same material and being connected to each other by at least one strip likewise consisting of this same material, and that between the circumferential edge of the diaphragm and the outer edge a capillary space is present in which a polymer is provided as a connection.

Additionally, the invention further provides a method characterized in that a diaphragm is formed from a sheet-like material, having a central portion and a circumferential edge located at a capillary distance from the central portion, while between the central portion and the circumferential edge at least one connecting strip is present and that in the capillary space between the central portion and the circumferential edge a flexible polymer is provided.

This second embodiment has the further advantage that the number of process steps is reduced; that errors can more easily be corrected, in particular before the polymer is provided, and that the diaphragm is suspended very flexibly from the circumferential edge, which is connected to the case, so that forming the suspension, as when a film is used, is no longer necessary. Furthermore, in this embodiment, the diaphragms can be manufactured inexpensively in mass production by means of punching. Automatic assembly of the diaphragms is equally possible.

The invention will be further elucidated below on the basis of an exemplary embodiment with reference to the drawings. In the drawings:

Fig. 1 is a cross-sectional elevation of a transducer with a diaphragm; and

Fig. 2 is a perspective view of a diaphragm according to the invention.

The present invention will be briefly explained with reference to Fig. 1, showing a known electroacoustic transducer 1.

The electroacoustic transducer 1 comprises a case 2 consisting of two parts, namely a first case part 3 and a second case part 4. The case 2 is generally shaped as a rectangular box, and the two case parts 3 and 4 generally have a substantially U-shaped cross section, the concave sides of the case parts 3 and 4 facing one another and, when assembled, enclosing the interior of the case 2. In the following, the first case part 3 will also be designated by the term "lid" and the second case part 4 will also be designated by the term "dish".

In the interior of the case 2 a diaphragm 5 is positioned. The diaphragm 5 has a central diaphragm portion 6, and an edge portion 7 extending therearound, intended for fixing the diaphragm 5 to the case 2. Between the central diaphragm portion 6 and the edge portion 7, the diaphragm 5 has a transition portion 8, which may be shaped as a pattern of folds.

Mounted on the dish 4 is an actuator 9, which is coupled by means of a movement transmission member 10, hereinafter referred to as "fork", to the central diaphragm portion 6.

Since the nature and construction of the actuator 9 are no subject matter of the present invention, and the skilled person does not need any knowledge thereof for a proper understanding of the present invention, while moreover use can be made of an actuator known per se, these aspects will only be described briefly. The actuator 9 comprises an electric coil 11 being connected by means of an electric wire 12 extending through the dish 4, to terminals 13 mounted on the outer surface of the case 2. In a magnet housing

14 a magnetic element 15 is arranged. An air gap 16 of the magnetic element 15 is aligned with an air gap 17 of the coil 11. A U-shaped armature 18 has a first leg 19 being connected to the magnet housing 14 and a second leg 20 extending in the air gaps 16 and 17 which are in alignment with each other. Connected to the end of the second armature leg 20 is the fork 10.

When an externally generated current is presented to the coil 11, a force is applied to the armature 18 by an interaction between the fields generated by the magnetic element 15 and the coil 11. Thus, a displacement is generated in the longitudinal direction of the fork causing the diaphragm to vibrate in order to generate a pressure wave.

The lid 3 has an opening 21, through which the interior of the case 2, located between the lid 3 and the diaphragm 5, communicates with the exterior world. Connected to the case is a substantially cylindrical snout 22, to which, if so desired, a flexible tube can be connected for conducting pressure waves.

As is shown in Fig. 1, in the electroacoustic transducer 1, the edge portion 7 of the diaphragm 5 is positioned in a plane parallel to the plane defined by the central diaphragm portion 6.

The edge portion 7 of the diaphragm 5 is fixed, for instance by way of gluing, to the free end edges of the side walls of the dish 4. These free end edges define a surface which is suitable for attaching the edge portion 7 of the diaphragm 5, and whose width is defined by the thickness of the side walls of the dish 4. Such method of connecting the diaphragm is known from NL-A-1004877.

According to the invention, a flexible polymer can be provided in a capillary space between the edge portion or the circumferential edge 7 of the diaphragm 5 and the inner wall of the case 4 to attach the circumferential edge 7 and thus the diaphragm 5 to the dish 4 of the case.

In the first embodiment of the invention, the central diaphragm portion 6 is attached to a film and a polymer is provided in a capillary space between

the outer edge of the film and the case wall. This embodiment is not shown in the drawing, since the construction is virtually the same as that in the construction in Fig. 1, the only difference being that there is no diaphragm portion between the lid and the dish of the transducer case.

Fig. 2 schematically shows a diaphragm according to a second embodiment of the invention, such as it can be applied in the transducer according to Fig. 1. The central diaphragm portion 6 and the circumferential edge 7 are connected to one another by means of one or more connecting strips or bridges 23. The diaphragm 5 can be simply punched out of a sheet of material, for instance aluminum. The central portion is freely movable relative to the circumferential edge. In the capillary interspace 8 the flexible polymer is provided. In this embodiment, the diaphragm can, if so desired, be connected with its edge portion between the free end edges of the lid 3 and dish 4.

## CLAIMS

1. An electroacoustic transducer (1), comprising:

a case (2);

a diaphragm (5) disposed in the case (2), comprising a central diaphragm portion (6) and an edge portion (7) extending therearound;

means (8, 9) for, respectively, converting an electric signal to a vibration of the central diaphragm portion (6), or converting a vibration of the central diaphragm portion (6) to an electric signal, while the edge portion (7) of the diaphragm (5) is connected to a wall portion of the case (2);

characterized in that the diaphragm is provided on a film, such that along at least a part of the circumferential edge of the diaphragm a free strip of film is present, and that between the circumferential edge of the film and the inner wall of the case a capillary space is present, in which a polymer is provided as a connection between the circumferential edge and the inner wall of the case.

2. An electroacoustic transducer (1), comprising:

a case (2);

a diaphragm (5) disposed in the case (2), comprising a central diaphragm portion (6) and an edge portion (7) extending therearound;

means (8, 9) for, respectively, converting an electric signal to a vibration of the central diaphragm portion (6), or converting a vibration of the central diaphragm portion (6) to an electric signal, while the edge portion (7) of the diaphragm (5) is connected to a wall portion of the case (2);

characterized in that the diaphragm comprises a central portion and a circumferential edge, located in the same plane, spaced apart from the outer edge of the central portion, the central portion and the circumferential edge consisting of the same material and being connected to each other via at least

one strip also consisting of this material, and that between the circumferential edge of the diaphragm and the outer edge a capillary space is present in which a polymer is provided as a connection between the circumferential edge and the outer edge.

3. A method for manufacturing a transducer according to claim 1, characterized in that the diaphragm is attached onto a film, such that along the circumferential edge of the diaphragm a free strip of film remains present and that in a capillary space between the circumferential edge of the film and the inner case wall a polymer of low viscosity is provided to connect the edge of the film with the case wall.

4. A method for manufacturing a transducer according to claim 2, characterized in that a diaphragm is formed from a sheetlike material, said diaphragm having a central portion and a circumferential edge spaced apart from the central portion, while between the central portion and the circumferential edge at least one connecting strip remains present and that in a capillary space between the central portion and the circumferential edge a flexible polymer is provided.

5. A method according to claim 3 or 4, characterized in that, as polymer, polybutene is used.

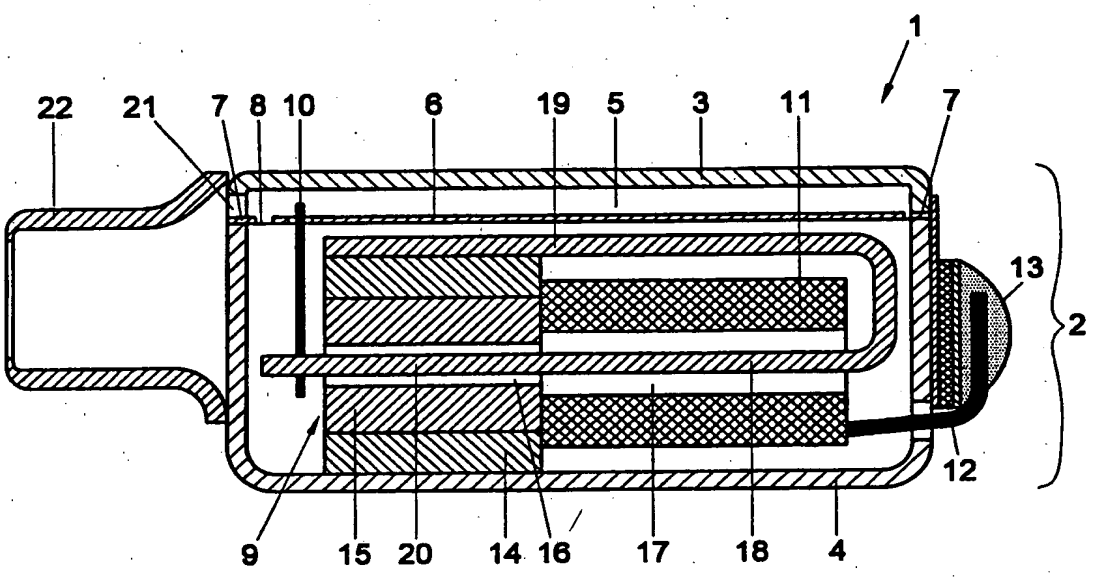


Fig. 1

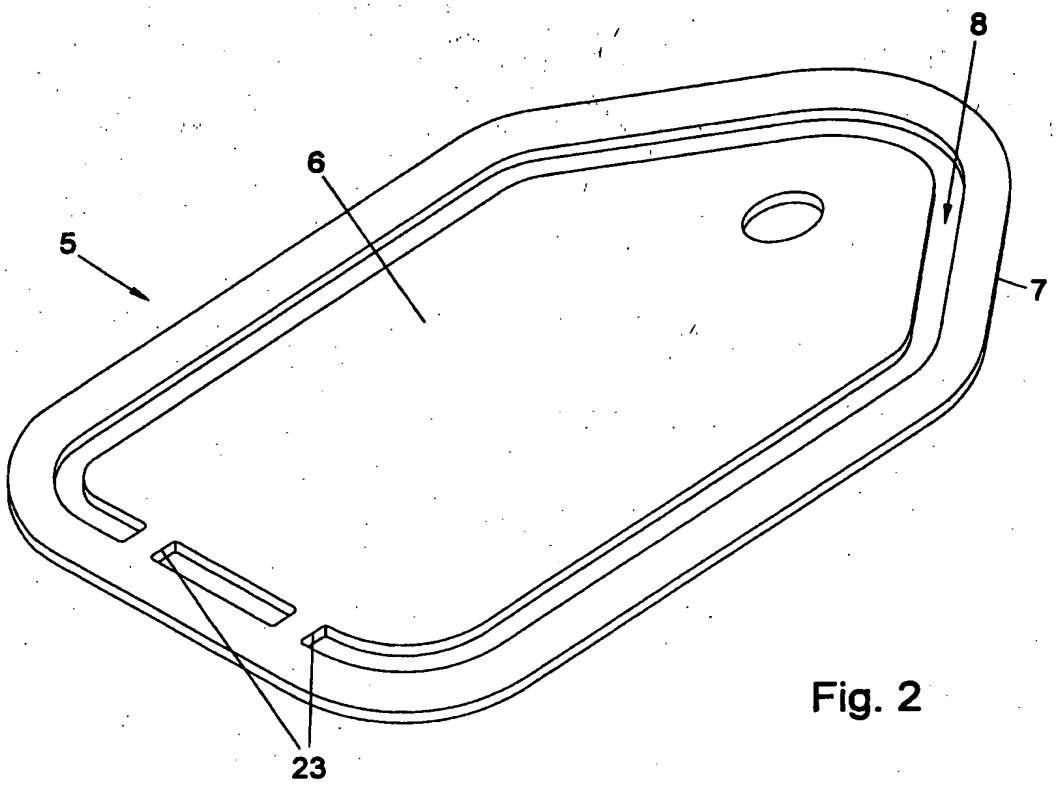


Fig. 2

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A. CLASSIFICATION OF SUBJECT MATTER
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